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Feature Article - Revisions to Quarterly Economic Growth Rates 1984-1993

INTRODUCTION

Economic analysts and policy makers require timely information on the direction and magnitude of the principal economic growth indicators. They must also have confidence that the intrinsic information contained in these indicators is unlikely to change significantly as more complete data become available.

This article reports the findings from an analysis of revisions to the first published estimates of quarterly growth in Gross domestic product(GDP) and its major expenditure and income components, over the decade 1984 to 1993. When compared with estimates compiled three years later, initial estimates of the higher level aggregates - including GDP(A) - were generally found to provide a consistent indication of the magnitude and direction of growth. Among the component series, however, initial estimates of growth in private sector expenditures were generally found to be conservative, while growth in the public sector tended to be overstated by the initial statistics. Initial estimates for GDP(E), at current and constant prices, were found to provide less reliable indications of the direction or magnitude of growth than the other GDP measures.

It must be stressed that the findings in this article are based on an analysis conducted on an historical basis. Users are cautioned against interpreting historical patterns of revisions as an indication of the likely level of revisions to contemporary and future estimates. Changes in the way in which the estimates are compiled, improvements in data sources or even changes in the reporting patterns underlying the estimates can and do affect the pattern of revisions over time. For example, improvements in the reliability of initial estimates of government expenditure and building activity in recent years would have improved the extent of revisions of many key series and hence led to reduced revisions to them. However, this improvement would not be evident from the historical analysis of revisions underlying this article.

The introduction of new concepts, data sources and methodologies designed to improve the quality of economic statistics inevitably impacts upon users' perceptions of the quality and reliability of those statistics. Such enhancements, which are generally made with the aim of improving the overall quality of statistics, may result in substantial revisions to the levels and growth rates of previously published data as changes are phased in. However, in the medium term the introduction of these changes (particularly those associated with better data sources or improved methodology) should reduce the revisions to initial estimates. Nonetheless, the compilation of the national accounts is an inherently complex process and one could expect to see some degree of revision to the estimates, regardless of whatever improvements can be made.

In the near future, the ABS is proposing to introduce a number of far-reaching reforms to the statistical compilation processes for the national accounts. The accompanying article, 'Improving the Quality of the National Accounts', (pages 15-17), describes the recent and planned improvements to the national accounts.

The ABS intends to regularly monitor and analyse revisions to the key national accounting aggregates - during and after the implementation of these major methodological changes. The results should assist users to gauge the impact of the changes - possibly against the benchmark of the current analysis. This article concludes by canvassing some options for future analyses, having regard to the differing perspectives of key groups of users of economic statistics.

REVISIONS AS A MEASURE OF QUALITY

Key economic statistics must be made available to the public at a suitable time for the majority of users - and certainly before they lose their relevance to current economic analysis and policy formulation. This 'deadline' almost always occurs long before the statistics are 'finalised'. The objective of the statistician is to ensure that initial estimates are compiled using the most appropriate methods from adequate data sources - so that users may have confidence that the initial estimates will be consistent with future estimates based upon more comprehensive data sources.

Timeliness and the reliability of the early estimates are only two of the criteria which must be considered when assessing the overall quality of statistics. Other aspects include the integrity of the conceptual framework in which the statistics are compiled, the relevance of the definitions employed within that framework, the accuracy with which the defined data items are measured and the coherence of the final estimates.

While revisions represent one of the most easily quantified aspects of statistical reliability, they do not provide an unambiguous guide to quality. For instance, few revisions may sometimes merely indicate that later data is no more reliable than initial estimates. Neither is it necessarily desirable for the statistician to give precedence to the objective of minimising revisions. It is entirely possible, for example, to compile initial estimates which make optimal use of the available data and which have low revision levels, but which:

- are nonetheless inaccurate, due to poor (initial and final) data sources;

- do not satisfactorily measure the aspect of the economy in which users are really interested;

- take so long to compile that they are no longer relevant to users; or

- require that an unacceptable load be placed upon survey respondents.

Revisions can, however, prove useful indicators to the possibility of inaccurate source data or inefficient compilation methodologies. If it can be established that:

- revisions to initial estimates are significantly more likely to be positive rather than negative, or vice versa; or;

- the mean of revisions is significantly greater than or less than zero (possibly driven by a small number of large deviations),

then it is self-evident that such estimates are inaccurate. Failure to account for known deficiencies of this type in the initial estimates would also constitute inefficiency in the estimation process.

It may be deduced that initial estimates of a given data item are both inaccurate and inefficient if

it can be shown conclusively that revisions may be reduced by employing additional (contemporaneous) information or alternative methods of compilation. In such cases, it is incumbent upon the ABS to investigate and eliminate any systematic distortions arising from the estimation process.

Users may sometimes classify statistics as unreliable even though they are compiled efficiently and accurately (within the limitations of the available data sources). One example might be statistics subject to frequent revisions whose magnitudes are large relative to the underlying movement in the statistics. In this case, the unreliability is shown by revisions which have the potential to substantially alter the magnitude or even the direction of economic change indicated by the initial statistics. In general, such problems may only be addressed by extending the current statistical collections.

Finally, it is important to note that the ABS is constantly reviewing and developing its compilation procedures. Users are therefore advised to treat the results presented in this article as a benchmark against which future revisions may be compared - and not as a guide to the likely characteristics of future revisions.

SOURCES OF REVISIONS

Revisions are a natural consequence of the statistical process, arising from the progressive incorporation of more up-to-date information as it becomes available. For example, the initial estimates for the quarterly national accounts are based upon the survey responses received and processed to that time. Late responses, and the resultant amended adjustments for non-response, will lead to revisions when they are subsequently included in the estimates.

For many data items, the quarterly survey data provide only partial indicators of the economic aggregate which is to be measured. Superior (but less timely) estimates are often available from annual (or less frequent) collections. The process of adjusting the quarterly indicators so that they are consistent with the more accurate annual estimates is known as benchmarking. Benchmarking typically leads to revisions over an extended period of time - often several years. Before the annual benchmarks become available, the quarterly estimates are compiled by extrapolating the benchmarked data of earlier years, generally using quarterly indicator series that are known to have a good relationship with the underlying aggregate being measured. These extrapolations will be revised successively as the quarterly indicator data are revised and again once new benchmarks become available. Often the first benchmark data to become available are also preliminary estimates, and therefore subject to revision over successive quarters or years. Moreover, the mathematical method by which the quarterly estimates are adjusted to the benchmarks can itself lead to characteristic patterns of revisions - sometimes restricted to the current year, but usually impacting upon the estimates for adjacent years.

Seasonally adjusted estimates will usually experience some degree of revision over several years, due to the prolonged period required to finalise the estimation of seasonal adjustment factors.

In the past, constant price estimates have been subject to substantial revisions approximately every five years due to the updating of the base year for which these estimates are calculated. This has generally led to substantial upward revisions to the levels of those estimates, but somewhat less predictable revisions to growth estimates.(See **Endnote 1**)

From time to time, the availability of a major new data source or development of a superior estimation method may allow the reassessment of previous estimates for an existing time series of data or the introduction of a totally new data item. For example, in the mid-1980s, the national accounts underwent considerable revisions stemming from the incorporation of some major

conceptual and other large one-off improvements:

- The introduction of a new public finance processing system in the December quarter 1984 provided the opportunity to apply significant conceptual changes to those aggregates with a significant public sector component.

- Also in the December quarter 1984, estimates for Private gross fixed capital expenditure - Real estate transfer expenses were introduced.

- In the December quarter 1985, large revisions were made to Gross operating surplus to more adequately account for the understatement of business income in tax statistics.

- Also in the December quarter 1985, large revisions to Private gross fixed capital expenditure - dwellings were included as a result of improved estimates for the alterations and additions component from the 1984 Household Expenditure Survey.

- Major changes were again effected in the December quarter 1986 with the adoption of Australian Accounting Standard 17 (concerning the treatment of leases), current replacement cost depreciation, and the changed treatment of road maintenance expenditure.

- In the June quarter 1987 accounts, the treatment of payroll tax paid by government departments reverted to the pre-December 1984 position (i.e. excluded from Government final consumption expenditure and netted off against Indirect taxes).

- In 1991-92, a review of public finance statistics led to substantial improvements in the quality of those statistics.

- In 1992, the decision was made to record merchandise exports at the date of shipment rather than the date of processing (by the Australian Customs Service).

DESCRIPTION OF ANALYSIS UNDERTAKEN

The statistical investigation reported in this article examines ten years of economic data from the Domestic Production Account - published in **Australian National Accounts: National Income, Expenditure and Product** (ABS cat. no. 5206.0). Initial estimates of quarter-on-quarter growth over the period from the March quarter 1984 to the December quarter 1993 are compared with the corresponding 'revised' estimates published three years later. The focus is on the growth rates derived from seasonally adjusted estimates of the key income and expenditure aggregates, as well as the headline estimates of GDP.

The decision to analyse revisions to quarterly growth rates is motivated by the prominence given to those estimates at the time of release. In addition, by focusing upon growth rates it is possible to partly abstract from the effects of irregular or one-off revisions to levels arising, for example, from the introduction of major conceptual changes or the rebasing of constant price estimates. As the analysis focuses upon revisions measured over a fixed interval of three years (rather than revisions between the initial estimates and estimates based on the current state of the data), the statistics may subsequently be compared, on a consistent basis, with corresponding statistics for different time periods.

Tables **A.1** and **A.2** in the **Statistical Appendix** report a range of descriptive statistics which are designed to characterise the reliability properties of the initial growth estimates for 27 key economic aggregates, as measured by revisions. **Table A.1** reports descriptive statistics for revisions to quarterly growth rates in seasonally adjusted current price estimates, while **Table A.2**

reports the corresponding statistics for seasonally adjusted constant price estimates.

In both tables, the statistics which summarise the behaviour of the data over ten years (or 40 quarterly observations for most data items) are contrasted with the statistics calculated from the last five years (20 quarters) of the sample. It is important to appreciate the overlapping nature of these statistics, and to recognise that significant differences between these two measures are indicative of an even more marked difference between the characteristics of the first and second halves of the sample period. Note that a number of major conceptual changes to the accounts (listed in the previous section) were concentrated in the first
half of the decade.

While the descriptive statistics are explained in greater detail in the **Statistical Appendix,** it is worth reviewing the key measures which appear in the following commentary on the results:

- If the mean or average revision is judged to be significantly greater than or less than zero on the basis of standard statistical criteria, then the initial estimates are said to exhibit systematic bias.

- The usefulness of the mean revision as a measure of systematic bias may be compromised by the occurrence of a small number of extreme or atypical revisions. In such cases, the median revision will often provide a more stable measure of bias. For this reason, the median is used to define the measure of relative bias - the ratio of the median revision to the mean absolute growth rate in the published data (expressed as a percentage).

- The median absolute revision is used to characterise the magnitude of revisions to initial estimates. It is quite possible for revisions to average zero (i.e. no systematic bias) but for individual revisions to still vary considerably about this overall average. Particular prominence is given to the measure of relative magnitude as a key indicator of the (un-)reliability of the initial growth estimates. High measures of relative magnitude (especially those in excess of 100%) indicate that revisions are often large relative to the average quarter-to-quarter movement in the data. Of particular concern is the probability that revised growth estimates may be of opposite sign to the initial estimates. In cases where the relative magnitude measure suggests major deficiencies in the initial estimates, the frequency of sign reversal is quoted to confirm the extent of the problem (See **Endnote 2**).

The quarterly growth rates analysed in this study are all derived from seasonally adjusted data. Revisions arising from the seasonal adjustment process will thus contribute to the overall extent of revisions observed. These changes can sometimes significantly raise the magnitude of revisions but would not be expected to have a major impact upon measures of bias.

In the case of constant price data, it will frequently be the case that initial growth estimates will be compared with revised estimates having a different base year. The identification of revisions due to rebasing is not an objective of this study, but it is useful to recognise that such revisions may contribute to apparent anomalies in the revisions to current and constant price growth estimates for individual data items.

MAIN FINDINGS
 TABLE 1: REVISIONS TO QUARTERLY GROWTH RATES IN GROSS DOMESTIC PRODUCT
- SUMMARY

	Sample Period Qtrs ended	Qtrs no.	Mean revision % points	Relative bias %	Relative magnitude %	Negative revisions %	Largest revision % points
Constant price estimates							
GDP (E)	Mar-84 to Dec 93	40	0.09	10.9	73.5	47.5	2.53
	Mar-89 to Dec -93	20	-0.04	-3.9	85.4	50.0	2.20
GDP (I)	Mar-84 to Dec 93	40	0.13	9.4	40.5	45.0	2.69
	Mar-89 to Dec -93	20	0.13	6.5	52.5	50.0	1.04
GDP (P)	Jun-88 to Dec 93	23	0.19	9.3	50.0	47.8	1.43
	Mar-89 to Dec -93	20	0.20	15.0	54.4	45.0	1.43
GDP (A)	Jun-88 to Dec 93	23	0.10	10.9	48.3	47.8	1.05
	Mar-89 to Dec -93	20	0.09	4.2	51.1	50.0	1.05
Current price estimates							
GDP (E)	Mar-84 to Dec 93	40	0.08	3.0	35.3	47.5	-1.87
	Mar-89 to Dec -93	20	0.03	-0.80	29.6	55.0	1.30
GDP (I)	Mar-84 to Dec 93	40	0.11	5.1	24.7	42.5	-1.71
	Mar-89 to Dec -93	20	(a) 0.19	13.9	25.9	40.0	1.24

(a) Denotes stistical significance at the 10% level - see **Statistical Appendix**

Gross domestic product (at current and constant prices) (see **Table 1** and **Tables A1** and **A2** in the **Statistical Appendix**)

Initial estimates of quarterly growth in constant price GDP were subjected to roughly equal numbers of upward and downward revisions - whether measured by the expenditure, income or production approach. Mean and median revisions tended to be positive, suggesting a small negative bias in the initial estimates of growth. However, these biases did not prove to be statistically significant.

Revisions to the expenditure-based (GDP(E)) measure of growth, at constant prices, were found to be larger than for the alternative GDP measures. In 50% of cases, the magnitude of revisions exceeded 0.75 percentage points, while in about 25% of cases, the initial estimates of GDP(E) gave an erroneous indication of the direction of growth. (Note: Sign reversal statistics are not shown in the tables.)

Over the decade 1984 to 1993, growth estimates based upon the constant price income-based (GDP(I)) measure generally experienced much smaller relative revisions than the GDP(E) estimates and showed no evidence of systematic bias. In current price terms, though, initial estimates of GDP(I) were found to under-estimate the revised rate of growth by an average of 0.19 percentage points per quarter during the latter half of the sample period (i.e. 1989 to 1993).

Over the last five years of the sample period, the relative bias of the production-based (GDP(P)) measure of growth exceeded the relative bias in the real GDP(E) and GDP(I) measures. That is, initial growth estimates derived from GDP(P) tended to be more conservative. (See **Endnote 3**)

Since GDP(A) is derived as the arithmetic mean of the three measures of GDP at constant prices, it may be expected to exhibit less volatile quarterly movements and smaller revisions. This is confirmed by the analysis. While GDP(A) must, by definition, inherit a share of any biases present in its component measures, no evidence of significant bias was detected.

While no significant bias was detected in the initial growth estimates of GDP(E) and GDP(I), several component aggregates nonetheless displayed significant bias over the period 1984-1993. As a general observation, initial estimates of growth in the public sector tended to be inflated (requiring subsequent downward revision), while initial estimates for the private sector tended to be conservative (requiring upward revision).

On the expenditure side of the accounts, the positive mean revision to **Private sector Gross fixed capital expenditure** (GFCE) tended to slightly dominate the negative mean revisions to **Public sector GFCE** and **Government final consumption expenditure**.

On the income side (in current prices), the mean revisions to **Wages, salaries and supplements and Indirect taxes less subsidies** were positive, offsetting the negative mean revision to **Gross operating surplus** (especially the general government component of GOS).

Expenditure Components (at current and constant prices) (see **Tables A1** and **A2** in the **Statistical Appendix**)

Final consumption expenditure

Initial estimates of quarterly growth in Private final consumption expenditure proved to be highly consistent with their corresponding revised estimates. In both current and constant price terms, the mean and median of revisions were measured at less than 0.1 percentage point. The relative magnitude measures were lower than for any other aggregate, and there is no evidence of systematic bias - despite quite significant benchmarking adjustments to the level of the estimates over the period. By contrast, the initial constant price growth estimates for Government final consumption expenditure were biased (relative bias = -71.6%) and unreliable (relative magnitude = 191%). In about 40% of cases, the direction of growth indicated by the initial estimates was subsequently reversed within three years.

Gross capital formation

While mean and median revisions to the aggregate Gross capital formation(GCF), measured in current prices, were comparatively small (relative bias = 1.6%) and exhibited no signs of systematic bias, it is notable that the two dominant components of GCF (Private and Public gross fixed capital expenditure) both showed strong evidence of bias in initial estimates. However, the significant negative bias in the initial estimates of Private sector GFCE growth (understated by 1.41 percentage points) plus Change in stocks almost exactly offset the significant positive bias in the initial Public sector GFCE growth estimates (overstated by 1.94 percentage points on average). Similar biases are evident in the constant price component estimates for the period, although in this case the biases do not balance. The negative bias arising from Private sector GFCE plus Change in stocks exceeded the positive bias contributed by Public sector GFCE, resulting in a net negative bias in initial estimates of GCF growth of 0.58 percentage points.

Private sector GFCE

Two-thirds of all revisions to initial constant price growth rates for Private sector gross fixed capital expenditure were positive. The mean revision was 1.33 percentage points, which is judged to be highly significant by the statistical criteria used in this study. While there is evidence that the magnitude of the bias decreased between the first and second halves of the sample period, the hypothesis of unbiasedness is still strongly rejected by the data for 1989 to 1993. Similar negative biases are evident in the initial current price estimates. In almost one quarter of cases, initial indications of the direction of growth in Private sector GFCE at constant prices were reversed by subsequent revisions.

All four component aggregates contributed to the negative bias in initial estimates of Private sector GFCE, but the most significant source of bias was clearly the investment in Equipment component, with a mean revision of 1.82 percentage points in constant price terms.

While it is difficult to identify systematic bias in the revisions to investment in Non-dwelling

construction, these revisions were, on average, much larger and more volatile than the revisions to Equipment - reporting high measures of relative bias and relative magnitude. Between 1984 and 1993, almost 50% of the initial estimates for Non-dwelling construction indicated the incorrect direction of quarterly growth.

Public sector GFCE

Initial constant price estimates of growth in Public sector gross fixed capital expenditure were revised downwards, on average, by 1.92 percentage points per quarter. The relative magnitude measure of 109% indicates that the magnitude of revisions to growth frequently exceeded the mean absolute growth rate. From examination of the current price data, it can be concluded that both components of Public sector GFCE display a tendency for positive bias. Two-thirds of revisions to GFCE by General government were negative, and the mean revision of -1.73 percentage points is statistically significant. The mean revision to growth in GFCE by Public enterprises was -2.26 percentage points.

International trade

The mean revisions to Exports and Imports of goods and services were small and display no significant bias. However, 50% of revisions to individual constant price estimates exceeded 1.7 percentage points in magnitude, leading to quite high measures of relative magnitude - especially for Exports between 1989 and 1993. While revisions to Imports were much smaller in the second half of the sample, they became more uni-directional - 70% of revisions to constant price growth in Imports between 1989 and 1993 were negative.

INCOME COMPONENTS (at current prices)

Wages, salaries and supplements

Revisions to Wages, salaries and supplements growth rates were generally small and rarely resulted in a change of sign. However, the initial estimates under-estimated the revised rate of growth by an average of 0.29 percentage points per quarter between 1989 and 1993.

Gross operating surplus

The most significant instance of positive bias on the income side of the accounts - as on the expenditure side - was provided by the public sector component. The mean revision of -0.36 percentage points per quarter to the GOS of General government was found to be statistically significant - although much of this result may be attributed to large negative revisions to the first two years of data following the inclusion of this aggregate in the accounts in 1986. There is little evidence of systematic bias or uni-directional revisions among the revisions to other components of GOS, although quite high measures of relative magnitude were recorded.

Indirect taxes less subsidies

The net income component Indirect taxes less subsidies contributes about 12% to estimates of the level of GDP. Initial quarterly growth estimates were revised upwards, on average, by 0.38 percentage points. This result, combined with the negative bias in initial estimates of Wages, salaries and supplements, helps to explain the apparent bias in initial estimates of growth in the income-based measure of GDP. While the quarterly movements in this component were much smaller in the second half of the sample period, the revisions were not - resulting in a considerable increase in the measure of relative magnitude.

GROSS FARM PRODUCT (at current and constant prices)

Early estimates of annual Gross farm product (GFP) typically rely upon medium-term forecasts of crop yields and commodity prices, while reliable and timely quarterly indicators are scarce. Under these circumstances, it might reasonably be expected that initial estimates of quarterly growth in GFP would be subject to considerable revision. While the range of revisions is rather broad (-6.09 to 11.52 percentage points for the constant price estimates) and the measures of mean, median and magnitude are comparatively high (especially for the current price data), the measures of relative bias and relative magnitude indicate that GFP estimates do not perform noticeably worse than most other initial estimates. The mean revision of 0.93 percentage points to constant price growth is statistically significant, but the median revision of 0.30 percentage points indicates a comparatively low relative bias of 10.3%.

MONITORING AND ANALYSING REVISIONS -- ISSUES AND OPTIONS

The recent improvements in source data, which are described in the accompanying article, will contribute to a pattern of future revisions that is different from the pattern observed in the past and, notwithstanding other changes that are made in the compilation of the national accounts, should lead to a reduction in the extent of revisions.

Over the next few years, the ABS proposes to substantially modify the compilation procedures for the national accounts. These innovations will impact upon the conceptual framework in which the accounts are compiled, the collection and reconciliation of source data and the methodologies employed to compute the published aggregates. Some of these modifications may lead to transient increases in the extent of revisions to the national accounts during implementation. In the longer term, however, the enhancement of the other aspects of statistical quality (especially accuracy and coherence) should more than compensate.

Users of ABS economic statistics will be interested in the impact of future revisions upon a wide diversity of analyses and decision-making processes. It is important then to ensure that future monitoring procedures are not narrowly focused upon particular data items and particular types of revisions. Conversely, a complete treatment of all aspects of the revisions process may overwhelm users with a vast amount of (largely redundant) material. It may be assumed that the majority of users will continue to be interested in likely revisions to the initial estimates of growth in GDP (measured in seasonally adjusted constant prices). However, in addition:

- some users will be interested in the full set of national accounts, while others may be interested only in selected aggregates (for example, investment, wages, corporate profits, international trade);

- users may be interested in particular forms of the national accounts time series, such as the trend series, the seasonally adjusted series, the original data series or the business cycle components (as defined, for example, for the ABS experimental Composite Leading Indicator);

- some users may be concerned about the levels of the estimates (measured in million dollars), while others may be interested only in quarterly or annual growth rates;

- some users will be interested only in the immediate impact of the statistics upon financial markets, others will have a short to medium term focus on the current economic cycle, while still others will have a long-term historical perspective;

- some users will be interested in the extent to which the estimates are revised between their first release and their final or near-final revised values, while others will be interested only in

the revisions that occur within the first 12 months following publication; and

- some users will be satisfied with qualitative assurances about the reliability of the estimates, while others will demand technically precise diagnostics.

The ABS also has much to learn from analyses of revisions. In addition to identifying less reliable estimates for individual data items, the ABS may initiate studies which will, for example:

- isolate the contributions of revisions arising from the seasonal adjustment process;

- identify the relative contributions to revisions in GDP arising from revisions to the main expenditure and income sub-aggregates;

- assess whether it is worthwhile to implement all revisions every quarter, or whether some alternative timetable for implementing revisions might be justifiable;

- assess how quickly (in elapsed quarters) early estimates approach their 'final' values; or

- assess whether specific changes to statistical collections or infrastructure have an impact upon the accuracy and reliability of early estimates.

In summary, no single style of analysis can display the patterns of revisions (and the ways in which those patterns may evolve over time) that are of interest to all users. The ABS is currently developing a suite of analytical techniques designed to monitor the impact of current developments and to address the concerns of
major groups of users. Suggestions or feedback from the readers of this article are encouraged and welcomed.

FURTHER INFORMATION

The analyses reported in this article were conducted by Peter Rossiter, an Assistant Director of the Analytical Services Section, ABS. For further information about the analyses contact Peter on telephone (02) 6252 6024, facsimile (02) 6252 8015 or e-mail peter.rossiter@abs.gov.au.

ENDNOTES

1. For most series, rebasing tends to reduce growth rates in recent periods, although the extent varies from series to series. The ABS will shortly be replacing its constant price estimates with chain volume measures, and this will essentially remove rebasing as a source of revisions to growth rates.

2. Sign reversal may clearly result from either small or large revisions - depending upon whether the initial growth estimate is 'close' to zero. However, as this statistic is quoted only in instances where revisions have already been identified as large (in a relative sense), it may be assumed that the proportion of 'insignificant' sign reversals is generally low.

3. Generally the quality of the source data underlying the quarterly estimates of GDP(P) tends to be less than the quality of data underlying the other two measures of GDP.

STATISTICAL APPENDIX

Tables A.1 and A.2 contain descriptive statistics which characterise the revisions, after three years, to initial estimates of quarterly growth rates. The initial estimates were published between the March quarter 1984 and the December quarter 1993 (40 quarters). The statistics calculated from 20 quarters of data pertain to the initial estimates published between the March quarter 1989 and the December quarter 1993. Revised estimates were extracted from publications released between the March quarter 1987 and the December quarter 1996.

The descriptive statistics include, for each economic aggregate:

- mean absolute growth rate (expressed as the percentage change per quarter) - defined as the average quarter-to-quarter growth rate, calculated without respect to sign, exhibited by the data over the sample period, computed from data published in the December quarter 1996 national accounts;

- mean or average of revisions (in percentage points) - a regression-based estimate of the mean, where allowance has been made for possible first-order serial correlation in the time series of revisions;

- median of revisions (in percentage points);

- relative bias (%) - defined to be the median of revisions expressed as a percentage of the mean absolute growth rate;

- magnitude or median absolute revision (percentage points) - defined as the median of revisions calculated without respect to sign;

- relative magnitude (%) - defined to be the median absolute revision expressed as a percentage of the mean absolute growth rate;

- % negative and positive revisions - the proportion of initial growth estimates subject to downward/upward revision; and

- largest negative and positive revisions.

Where the distribution of revisions is symmetric about the mean, the mean revision will be almost identical with the median revision. Divergence between these two measures will generally indicate that the estimate of the mean is being influenced by a small number of extreme cases. (The largest positive and largest negative revisions may prove informative in such instances.) Since the median is more robust to the presence of extreme outcomes, and is perhaps the more intuitive measure of the midpoint of the distribution, it is used in reference to the mean in the construction of the relative biasmeasure.

The median revision indicates the predominant direction of change between the initial and later growth estimates. The relative biasindicates whether the median revision is itself large relative to the average quarter-to-quarter movement. In summarising the findings for individual data items, it is often convenient to make reference to 'bias' in the initial estimates. To avoid confusion, note that a 'positive mean or median revision' equates to 'negative bias in the initial estimates'.

It is important to distinguish between patterns of revisions which are purely random and those which exhibit systematic bias. An indication of whether or not revisions to an aggregate are systematically biased can be obtained by assuming unbiasedness and then considering the likelihood of observing the current estimate of the mean revision. If the magnitude of the observed mean appears improbably large, taking account of the distribution of all the revisions, then it is said to be statistically significant. Estimates of the mean which are judged by standard statistical criteria to be significantly greater than or less than zero are highlighted in the tables. (A

significance level of 10% has been used.)

The average magnitude of revisions is computed as the median of the distribution of the absolute values of all revisions. As above, the median is preferred to the mean because it is a more stable measure when the distribution is skewed. The measure of relative magnitude is defined as the ratio of the median absolute revisionto the mean absolute growth rate. An alternative, though much less stable, measure could be obtained by computing the ratio of each revision to its respective initial (or final) estimate (without respect to sign) and taking the mean or median of the resulting distribution. The usefulness of the chosen measure depends to some extent on the supposition that the magnitudes of individual revisions are approximately independent of the magnitudes of their respective initial (or final) estimates. Since this may not be true, additional information concerning the incidence of sign reversal due to revisions has been provided in the commentary.

It seems intuitively desirable for initial estimates to undergo roughly equal proportions of positive and negative revisions. Where a major imbalance occurs, it is necessary to distinguish whether this is due to a small number of extraordinary revisions (affecting the whole time series of estimates) or systematic bias in the initial estimates. Such extraordinary revisions will generally also be reflected in the median bias and magnitude statistics. Serial correlation - which may be regarded as a minor systematic influence - may be detected in the time series of revisions to most aggregates, and is generally sufficient to explain small deviations from the 'equal probability' hypothesis.

The largest negative and largest positive revisions define the range of revisions to each aggregate in each time period. It is important to note that they are, by definition, extreme outcomes - often attributable to unusual or once-only circumstances.

TABLE A.1: REVISIONS TO QUARTERLY GROWTH IN SEASONALLY ADJUSTED CURRENT PRICE DATA - DESCRIPTIVE STATISTICS

Data description	Qtrs	Mean Absolute growth rate	Mean Revision	Median revision	Relative bias	Magnitude	Relative magnitude	Negative revisions	Positive revisions	Largest negative revision	Largest positive revision
	no.	% per qtr	% points	% points	%	% points	%	%	%	%	%points
EXPENDITURE ON GDP											
Final consumption expenditure -											
Private	40	2.11	0.07	0.01	0.4	0.31	14.7	47.5	52.5	-0.65	
	20	1.63	-0.05	-0.05	-2.9	0.22	13.7	60.0	40.0	-0.53	
Government	40	2.07	-0.25	-0.81	-39.3	1.60	77.2	57.5	42.5	-6.34	
	20	1.65	-0.05	-0.92	-55.9	1.65	100.1	60.0	40.0	-4.39	
Private gross fixed capital expenditure -											
Dwellings	40.0	3.99	0.21	0.70	17.6	1.98	49.6	42.5	57.5	-7.15	
	20	3.14	0.07	0.09	3.0	1.24	39.7	50.0	50.0	-5.00	
Non-Dwelling construction	40	5.20	0.90	2.21	42.5	5.18	99.7	42.5	57.5	-25.01	

Equipment	20	4.66	1.17	1.01	21.7	4.39	94.2	45.0	55.0	-10.44
	40	5.90	(a) 2.25	0.79	13.3	3.21	54.3	32.5	67.5	-15.92
Real Estate transfer expenses	20	5.81	(a) 1.70	0.57	9.9	0.80	13.8	30.0	70.0	-3.97
	37	6.13	0.31	0.73	11.9	1.98	32.3	40.5	5905	-10.38
Total Private sector GFCE	20	4.26	0.32	0.28	6.6	1.81	42.6	45.0	55.0	-5.73
	40	4.10	(a) 1.41	1.20	29.3	1.78	43.4	30.0	70.0	-9.25
Public gross fixed capital expenditure -	20	3.49	(a) 0.98	0.87	25.1	1.41	40.3	35.0	65.0	-1.70
Public enterprises	40	10.53	-2.26	-2.12	-20.1	8.22	78.1	52.5	47.5	-37.20
General government	20	11.72	-0.62	-0.409	-34.9	8.96	76.4	55.0	45.0	-16.6
	40	5.07	(a) -1.73	-1.52	-30.0	3.70	72.9	67.5	32.5	-21.17
Total public sector GFCE	20	5.30	(a) -2.97	-1.95	-36.8	3.54	66.8	75.0	25.0	-21.17
	40	6.05	(a) -1.94	-1.60	-26.4	5.82	96.1	60.0	40.0	-21.38
Gross Capital formation	20	6.16	-1.63	-2.48	-40.3	5.25	85.1	60.0	40.0	-10.69
	40	4.28	0.29	0.07	1.6	2.12	49.6	47.5	52.5	-8.75
Gross national expenditure	20	3.70	0.02	-0.24	-6.4	2.41	65.1	55.0	45.0	-3.87
	40	2.13	0.08	-0.09	-4.2	0.62	29.0	55.0	45.0	-1.63
Exports of goods and services	20	1.46	-0.02	-0.13	-8.8	0.50	34.5	55.0	45.0	-1.16
	40	3.87	-0.01	-0.10	-2.7	1.37	35.3	55.0	45.0	-3.83
Imports of goods and services	20	2.48	0.08	0.03	1.2	1.68	67.8	50.0	50.0	-3.56
	40	4.29	-0.03	-0.16	-3.7	1.31	30.6	55.0	45.0	-4.53
Gross Domestic Product (GDP(E))	20	3.48	-0.19	-0.21	-6.0	0.98	28.3	60.0	40.0	-4.53
	40	**2.13**	**0.08**	**0.06**	**3.0**	**0.75**	**35.3**	**47.5**	**52.5**	**-1.87**
INCOME COMPONENTS OF GDP	**20**	**1.52**	**0.03**	**-0.12**	**-0.80**	**0.45**	**29.6**	**55.0**	**45.0**	**-1.18**
Wages, salaries and supplements	40	2.03	(a) 0.19	0.32	15.8	0.64	31.7	40.0	60.0	-1.49
Gross operating surplus -	20	1.54	(a) 0.29	0.32	20.9	0.51	33.3	35.0	35.0	-0.96

Data description	Qtrs	Mean Absolute growth rate	Mean Revision	Median revision	Relative bias	Magnitude	Relative magnitude	Negative revisions	Positive revisions	Largest negative revision
Private corporate trading enterprises	40	3.70	-0.38	-1.02	-27.7	2.54	68.8	55.0	45.0	-4.75
	20	2.91	-0.36	-0.75	-25.9	2.65	91.4	55.0	45.0	-4.03
Other trading enterprises	40	2.27	0.14	0.01	0.6	1.30	57.2	47.5	52.5	-4.71
	20	1.23	0.20	-0.27	-21.7	0.88	71.4	60.0	40.0	-2.66
General government	29	1.20	(a) -0.36	0.38	-31.6	0.46	38.7	72.4	27.6	-1.69
	20	1.11	-0.16	-0.16	-14.8	0.30	26.7	60.0	40.0	-1.10
Total gross operating surplus	40	2.59	-0.09	-0.16	-6.0	1.20	46.4	50.0	50.0	-3.56
	20	1.62	0.04	0.26	16.0	1.08	66.8	45.0	55.0	-2.67
Gross domestic product at factor cost	40	2.16	0.07	0.23	10.5	0.55	25.5	47.5	52.5	-2.03
	20	1.52	(a) 0.17	0.36	23.6	0.47	30.8	40.0	60.0	-0.96
Indirect taxes less subsidies	40	3.54	0.38	0.13	3.8	1.64	46.5	42.5	57.5	-5.68
	20	2.13	0.35	0.03	1.5	1.77	83.1	45.0	55.0	-5.68
Gross domestic product (GDP(I))	**40**	**2.16**	**0.11**	**0.11**	**5.1**	**0.53**	**24.7**	**42.5**	**57.5**	**-1.71**
	20	**1.46**	**(a) 0.19**	**0.20**	**13.9**	**0.38**	**25.9**	**40.0**	**60.0**	**-1.08**
Gross farm product	40	5.32	(a) 1.26	0.17	3.3	3.16	59.5	50.0	50.0	-13.32
	20	5.94	1.74	2.16	36.4	3.68	61.9	45.0	55.0	-13.32
Gross non-farm product	40	2.15	0.07	0.13	6.3	0.57	26.6	40.0	60.0	-1.79
	20	1.41	0.15	0.15	10.9	0.32	22.9	30.0	70.0	-0.86

(a) Denotes statistical significance at the 10% level

TABLE A.2: REVISIONS TO QUARTERLY GROWTH IN SEASONALLY ADJUSTED CONSTANT PRICE DATA - DESCRIPTIVE STATISTICS

Data description	Qtrs	Mean Absolute growth rate	Mean Revision	Median revision	Relative bias	Magnitude	Relative magnitude	Negative revisions	Positive revisions	Largest negative revision
	no.	% per qtr	% points	% points	%	% points	%	%	%	%points
EXPENDITURE ON GDP Final consumption expenditure -										
Private	40	0.94	0.09	0.05	5.5	0.28	29.4	45.0	55.0	-0.68
	20	0.80	-0.03	-0.07	-8.7	0.21	26.7	60.0	40.0	-0.68

Government	40	1.24	-0.41	-0.89	-71.6	2.37	190.9	55.0	45.0	-6.95
Private gross fixed capital expenditure -	20	1.19	-0.29	-0.90	-75.1	1.80	150.8	60.0	40.0	-4.06
Dwellings	40	3.43	0.19	0.71	20.6	1.90	55.2	40.0	60.0	-6.78
Non-Dwelling construction	20	3.08	0.04	0.24	7.8	1.19	38.7	45.0	55.0	-5.50
	40	4.64	0.92	2.27	48.9	5.47	117.8	42.5	57.5	-23.87
Equipment	20	4.60	1.12	1.20	26.2	4.19	90.9	45.0	55.0	-11.99
	40	5.75 (a)	1.82	0.71	12.3	3.74	65.0	42.5	57.5	-12.45
Real Estate transfer expenses	20	5.79 (a)	1.17	0.48	8.3	1.32	22.9	40.0	60.0	-4.72
	37	4.61	0.40	0.12	2.6	2.38	51.7	48.6	51.4	-11.08
Total Private sector GFCE	20	4.25	0.63	-0.21	-5.0	1.88	44.2	50.0	50.0	-4.58
	40	3.66 (a)	1.33	1.30	35.5	1.82	49.7	35.0	65.0	-8.17
Public gross fixed capital expenditure	20	3.53 (a)	0.95	1.26	35.7	1.30	36.8	35.0	65.0	-1.51
	40	5.64 (a)	-1.92	-1.40	-24.9	6.15	109.2	57.5	42.5	-22.45
Gross Capital formation	20	5.91	-1.59	-3.53	-59.8	5.99	101.4	60.0	40.0	-10.62
	40	3.43 (a)	0.58	0.55	16.0	2.41	70.3	47.5	52.5	-6.13
Gross national expenditure	20	3.36	0.01	-0.13	-3.9	2.06	61.3	55.0	45.0	-4.25
	40	1.09	0.12	-0.02	-1.7	0.65	60.0	57.5	42.5	-1.21
Exports of goods and services	20	0.98	-0.06	-0.15	-15.7	0.30	31.0	70.0	30.0	-1.21
	40	2.96	-0.14	-0.16	-5.5	1.80	60.8	52.5	47.5	-4.72
Imports of goods and services	20	2.34	-0.13	-0.03	-1.4	2.01	85.9	50.0	50.0	-4.72
	40	3.45	-0.09	-0.48	-13.8	11.74	50.4	62.5	37.5	-4.83
Gross Domestic Product (GDP(E))	20	2.92	-0.31	-0.58	-19.8	1.05	36.0	70.0	30.0	-4.83
	40	**1.00**	**0.09**	**0.11**	**10.9**	**0.74**	**73.5**	**47.5**	**52.5**	**-1.63**
Gross domestic product (GDP(I))	**20**	**00.89**	**-0.04**	**-0.03**	**-3.9**	**0.76**	**85.4**	**50.0**	**50.0**	**-1.63**
	40	**1.05**	**0.13**	**0.10**	**9.4**	**0.43**	**40.5**	**45.0**	**55.0**	**-1.88**
Gross Domestic Product (GDP(P))	**20**	**0.81**	**0.13**	**0.05**	**6.5**	**0.43**	**52.5**	**50.0**	**50.0**	**-0.79**
	23	**0.83**	**0.19**	**0.08**	**9.3**	**0.42**	**50.0**	**47.8**	**52.2**	**-0.49**
Gross domestic product (GDP(A))	**20**	**0.76**	**0.20**	**0.11**	**15.0**	**0.41**	**54.4**	**45.0**	**55.0**	**-0.45**
	23	**0.77**	**0.10**	**0.08**	**10.9**	**0.37**	**48.3**	**47.8**	**52.2**	**-0.66**
	20	**0.73**	**0.09**	**0.03**	**4.2**	**0.37**	**51.1**	**50.0**	**50.0**	**-0.66**

Gross farm product	40	2.86	(a) 0.93	0.30	10.3	2.51	87.8	42.5	57.5	-6.09
	20	3.04	(a) 1.60	0.58	19.0	1.90	62.4	30.0	70.0	-5.13
Gross non-farm product	40	1.09	0.08	0.08	7.3	0.39	35.4	42.5	57.5	-1.77
	20	0.82	0.07	0.03	3.5	0.34	41.0	50.0	50.0	-0.84

(a) Denotes statistical significance at the 10% level

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